

REMARKS

The Final Office Action mailed February 26, 2008, has been received and reviewed. Claims 1 through 6, 9 through 15, and 64 through 66 are currently pending in the application. Claims 1 through 6, 9 through 15, and 64 through 66 stand rejected. Applicants propose to amend claim 1. No new matter is added. Reconsideration is respectfully requested herein.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on U.S. Patent No. 5,926,736 to DeSilva in view of U.S. Patent No. 5,420,072 to Fiordalice et al. and U.S. Patent No. 5,008,216 to Huang et al.

Claims 1 through 6, 9 through 14 and 64 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over DeSilva (U.S. Patent No. 5,926,736) in view of Fiordalice et al. (U.S. Patent No. 5,420,072) and Huang et al. (U.S. Patent No. 5,008,216). Applicants respectfully traverse this rejection, as hereinafter set forth.

To establish a *prima facie* case of obviousness the prior art reference (or references when combined) **must teach or suggest all the claim limitations**. *In re Royka*, 490 F.2d 981, 985 (CCPA 1974); *see also* MPEP § 2143.03. Additionally, the Examiner must determine whether there is “an apparent reason to combine the known elements in the fashion claimed by the patent at issue.” *KSR Int’l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1740-1741, 167 L.Ed.2d 705, 75 USLW 4289, 82 U.S.P.Q.2d 1385 (2007). Further, rejections on obviousness grounds “cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *Id* at 1741, quoting *In re Kahn*, 441, F.3d 977, 988 (Fed. Cir. 2006). To establish a *prima facie* case of obviousness there must be a reasonable expectation of success. *In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986). Furthermore, the reason that would have prompted the combination and the reasonable expectation of success must be found in the prior art, common knowledge, or the nature of the problem itself, and not based on the Applicant’s disclosure. *DyStar Textilfarben GmbH & Co. Deutschland KG v. C. H. Patrick Co.*, 464 F.3d 1356, 1367 (Fed. Cir. 2006); MPEP § 2144. Underlying the obvious determination is the fact that statutorily prohibited hindsight cannot be used. *KSR*, 127 S.Ct. at 1742; *DyStar*, 464 F.3d at 1367.

DeSilva teaches forming an interconnect structure by forming one or more holes within a insulating layer on a substrate, forming a barrier layer over the holes, placing the structure in a vacuum chamber, and depositing and forming an aluminum layer over the barrier layer. DeSilva at Figures 1 through 5 and column 2, line 30 through column 3, line 67. An antireflective coating is formed on the aluminum layer. *Id.* The structure is subsequently heated to melt the aluminum layer, allowing aluminum to fill in the holes within the insulating layer. *Id.*

Fiordalice teaches forming an interconnect structure by forming an opening within a dielectric material, depositing a first layer of titanium nitride over the dielectric material, depositing a second layer of titanium nitride over the first layer, and forming a conductive layer overlying the second layer. Fiordalice at FIGs. 1-6, column 2, line 48 through column 4, line 50. The first titanium nitride layer acts as a seed layer. Fiordalice, col. 3, lines 60-62; col. 4, lines 27-29. Alternatively, after depositing the second layer of titanium nitride, a conductive plug of tungsten material is deposited or layered such that the opening is substantially filled. *Id.* at FIGs. 7-8 and column 4, lines 50-62. Portions of the tungsten material are removed to expose portions of the second layer of titanium nitride. *Id.* at column 4, lines 62-65.

Huang teaches forming an interconnect by forming an opening within an insulator layer, blanket depositing a reactive adhesion layer 15 (titanium) into the opening followed by sputter depositing a seed layer 21 (tungsten, molybdenum) and depositing, by CVD, a refractory metal stud 17 (tungsten). (Huang, col. 3, lines 3-23). Thereafter, the refractory metal stud 17 is planarized.

Applicant submits that the presently claimed invention is not rendered obvious by the proposed combination of references. No motivation exists to combine the cited references as proposed. DeSilva is directed to methods of removing or voids in aluminum plugs. Huang is directed to alternatives to aluminum plugs and teaches method of preventing voids in tungsten plugs. Fiordalice is directed to depositing a conformal titanium nitride barrier lining separating an insulating layer and a metal plug.

The Examiner acknowledges that DeSilva fails to teach or suggest “forming a seed layer on the diffusion barrier layer over the top surface of the dielectric material and within the recess, the diffusion barrier layer comprising a material having a melting point greater than or equal to

that of a material of the seed layer, wherein the material of the seed layer comprises tungsten,” or “removing portions of the energy absorbing layer and the electrically conductive layer that are situated above the top surface of the dielectric material” as recited in claim 1 of the presently claimed invention.

The Examiner contends it would be obvious to incorporate the seed layer of Fiordalice because it would result in improved electromigration resistance and improved deposition of a conductive layer over the seed layer. (Office Action, page 5) However, the Fiordalice seed layer/first titanium nitride layer 22 is meant to ensure good coverage of the second titanium nitride layer 24 thereover. (Fiordalice, col. 3, lines 60-63; “First titanium nitride layer 22, however, acts as a crystallographic seed layer during the deposition of second titanium nitride layer 24, and as a result second titanium nitride layer 24 is conformally deposited having a preferred <111> crystal orientation.”) Further, claim 1 has been amended to recite, in part, “forming a seed layer on the diffusion barrier layer over the top surface of the dielectric material and within the recess, wherein the material of the seed layer comprises tungsten and wherein the material of the diffusion barrier layer is different from the material of the seed layer.” Support of the amendment may be found throughout the as-filed specification including, at least paragraphs [0022] and [0025] and in the claims as originally filed.

Fiordalice is directed to getting a conformal titanium nitride layer 22, 24 deposited. Fiordalice lacks any teaching or suggestion of removing voids by the process disclosed in DeSilva. Thus, one skilled in the art would not be motivated to try to combine the teaching Fiordalice with DeSilva. Further, Fiordalice teaches that the two layers 22, 24 underlying the conductive layer 26 are the same material and not that “the material of the diffusion barrier layer is different from the material of the seed layer” as recited in claim 1 of the presently claimed invention. Thus, the combination of DeSilva and Fiordalice cannot render claim 1 of the presently claimed invention obvious.

Additionally, no articulated reasoning with rational underpinning has been provided by the Examiner to support the legal conclusion of obviousness because the applied references do not provide a reason that would have prompted the combination. Specifically, nowhere in Fiordalice or DeSilva is there any articulated reasoning that would have prompted one of

ordinary skill in the art to modify the structure of DeSilva by adding a seed layer. Furthermore, neither DeSilva nor Fiordalice provides any articulated reasoning to change the first titanium nitride layer 22 of Fiordalice to be a different material, such as tungsten. In addition, the common knowledge or the nature of the problem does not provide a reason that would have prompted the combination.

The Examiner contends it would have been further obvious to form a seed layer of tungsten as taught by Huang. (Office Action, page 5) Applicant respectfully disagrees. First, one would not be motivated to substitute the tungsten seed layer of Huang for the second titanium nitride seed layer of Fiordalice. Fiordalice discloses using a first titanium nitride seed layer for forming a conformal titanium nitride barrier layer. The two titanium nitride layers are deposited under different conditions to ensure the formation of a conformal titanium nitride barrier layer. (Fiordalice, col. 3, lines 55-60).

Similarly, even assuming a motivation to include a seed layer in DeSilva exists, which Applicant does not concede, no motivation exists to incorporate the tungsten seed layer of Huang into the DeSilva device. Huang and DeSilva disclose alternate solutions to voids within aluminum plugs. Huang discloses using a tungsten (or molybdenum or tantalum) seed layer and a tungsten (or molybdenum or tantalum) plug. (Huang, col. 5, lines 6-13). By contrast, DeSilva teaches depositing an aluminum plug 118, depositing an overlying titanium nitride antireflective coating 124 and heating the device to cause the aluminum to reflow and eliminate voids therein. Huang lacks any disclosure of the heating process described by DeSilva and lacks any disclosure of using aluminum. The Examiner has not identified why one skilled in the art would be motivated to combine the two teachings. Clearly, the Huang and DeSilva references are directed to alternate methods and one skilled in the art would not have a reasonable expectation that the teachings could be successfully combined.

In light of the above, Applicant submits that independent claim 1 is allowable and, accordingly, requests withdrawal of the 35 U.S.C. 103(a) obviousness rejection.

The nonobviousness of independent claim 1 precludes a rejection of claims 2-6, 9-14, and 64 which depend therefrom, because a dependent claim is obvious only if the independent claim from which it depends is obvious. *See In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988), *see also* MPEP § 2143.03.

Therefore, Applicant respectfully requests that the Examiner withdraw the 35 U.S.C. § 103(a) obviousness rejection of independent claim 1 and claims 2-6, 9-14, and 64, which depend therefrom.

Obviousness Rejection Based on U.S. Patent No. 5,926,736 to DeSilva in view of U.S. Patent No. 5,420,072 to Fiordalice et al. and U.S. Patent No. 5,008,216 to Huang et al. as applied to claims 1-6, 9-14 and 64 above, and further in view of U.S. Patent No. 5,869,395 to Yim

Claim 15 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over DeSilva (U.S. Patent No. 5,926,736) in view of Fiordalice et al. (U.S. Patent No. 5,420,072) and Huang et al. (U.S. Patent No. 5,008,216) as applied to claims 1-6, 9-14 and 64 above, and further in view of Yim (U.S. Patent No. 5,869,395). Applicants respectfully traverse this rejection, as hereinafter set forth.

Claim 15 is allowable because a dependent claim is obvious only if the independent claim from which it depends is obvious. *See In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988), *see also* MPEP § 2143.03.

Obviousness Rejection Based on U.S. Patent No. 5,926,736 to DeSilva in view of U.S. Patent No. 5,008,216 to Huang et al.

Claims 65 and 66 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over DeSilva (U.S. Patent No. 5,926,736) in view of Huang et al. (U.S. Patent No. 5,008,216). Applicants respectfully traverse this rejection, as hereinafter set forth.

The teachings of DeSilva and Huang are incorporated herein. Applicant respectfully submits that the proposed combination of DeSilva in view of Huang fails to teach or suggest every element of independent claims 65 and 66.

Independent claims 65 and 66 of the presently claimed invention include similar limitations of “forming a seed layer on the diffusion barrier layer over the top surface of the dielectric material and within the recess, the diffusion barrier layer comprising a different material to that of a material of the seed layer, wherein the material of the seed layer is aluminum, titanium nitride, titanium, or titanium aluminide” and “forming a seed layer on the diffusion barrier layer over the top surface of the dielectric material and within the recess, the diffusion barrier layer comprising a material having a melting point greater than that of a material of the seed layer, wherein the material comprising the seed layer is aluminum, titanium nitride, titanium, or titanium aluminide.”

DeSilva lacks any teaching or suggestion of a seed layer. Huang discloses a seed layer made of a refractory metal (tungsten (W), molybdenum (Mo), niobium (Nb), tantalum (Ta), rhenium (Re)). (Huang, col. 5, lines 7-13). Thus, the combination of DeSilva and Huang fails to teach or suggest that the “material comprising the seed layer is aluminum, titanium nitride, titanium, or titanium aluminide” as recited in claims 65 and 66 of the presently claimed invention.

Further, no motivation exists to incorporate the seed layer of Huang into the DeSilva device. Huang and DeSilva disclose alternate solutions to voids within aluminum plugs. Huang discloses using a seed layer and a tungsten (or molybdenum or tantalum) plug. (Huang, col. 5, lines 6-13). By contrast, DeSilva teaches depositing an aluminum plug 118, depositing an overlying titanium nitride antireflective coating 124 and heating the device to cause the aluminum to reflow and eliminate voids therein. Huang lacks any disclosure of the heating process described by DeSilva and lacks any disclosure of using aluminum. The Examiner has not identified why one skilled in the art would be motivated to combine the two teachings. Clearly, the Huang and DeSilva references are directed to alternate methods and one skilled in the art would not have a reasonable expectation that the teachings could be successfully combined.

In light of the above, Applicant submits that independent claims 65 and 66 are allowable and, accordingly, requests withdrawal of the 35 U.S.C. 103(a) obviousness rejection.

ENTRY OF AMENDMENTS

The proposed amendments to claim 1 above should be entered by the Examiner because the amendments are supported by the as-filed specification and drawings and do not add any new matter to the application. Further, the amendments do not raise new issues or require a further search. Finally, if the Examiner determines that the amendments do not place the application in condition for allowance, entry is respectfully requested upon filing of a Notice of Appeal herein.

CONCLUSION

Claims 1 through 6, 9 through 15 and 64 through 66 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, the Examiner is respectfully invited to contact Applicant's undersigned attorney.

Respectfully submitted,



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